Cryogenic Sensor Test Facility

Laser photon source and He-3 cryostat in a shielded room

FUNCTION: Used for designing and testing hyperspectral (IR to X-rays) single-photon cryogenic detectors. These detectors can measure the "color" (energy) of individual photons without using dispersive elements such as diffraction gratings. The accuracy can be as high as 1 part in 10,000 for a 10 KeV photon. The facility provides a cryogenic environment for the detectors, ultra low-noise electronics, and a fast acquisition system.

INSTRUMENTATION: The He-3 cryostat provides access to temperatures as low as 0.3K. An X-ray source (Fe-55) can be placed inside the cryostat and covered or uncovered by external control. The cryostat has windows adjustable to external IR/visible/UV photons. A custom Nd-YAG laser (infrared radiation: λ=1.06 mm) with frequency doubling (green: λ=532 nm) and tripling (UV: λ=353 nm) produces trains of sub-nanosecond pulses. Cryogenic electronics include SQUID-array amplifiers, with current noise 2 pA/Hz$^{1/2}$, bandwidth > 10 MHz, input impedance 4-250 nH, and transimpedance gain 100-1000 Ω.

DESCRIPTION: The Cryogenic Sensor Test Facility is an electromagnetically screened room with a sub-Kelvin temperature cryostat, photon sources (X-ray, UV, optical and infrared photons), very low noise cryogenic and room temperature electronics, and a signal processing system. It was built to support the development of nondispersive single-photon detectors. It was initially based on superconducting tunnel junction designs for X rays, and later modernized for development of hyperspectral QVD detectors, which can cover a wide range of wavelengths from X rays to IR. In the QVD design, the energy deposited by a photon into the detector is thermoelectrically converted into the voltage with subsequent digital readout at the cold stage for a multipixel array configuration. Since the QVD is still at the developmental stage, the facility is very flexible and has tools and equipment that can be easily reconfigured and upgraded.

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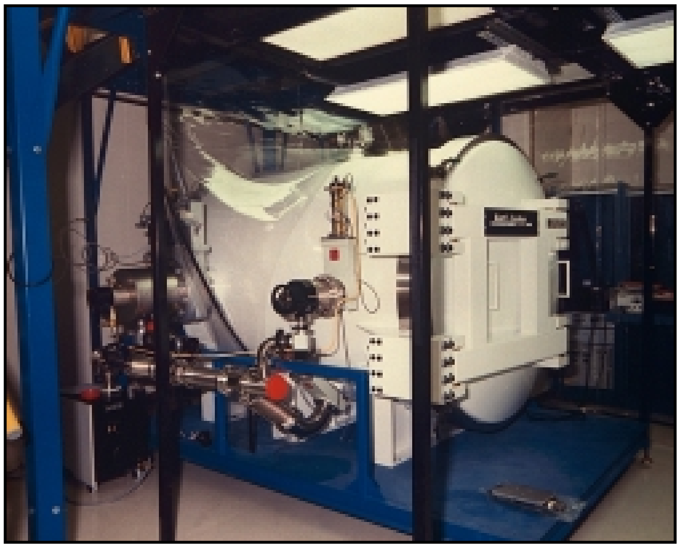
Vacuum Ultraviolet Calibration/Testing Facility



Vacuum Ultraviolet Calibration / Testing Facility

FUNCTION: Provides an oil-free high-vacuum chamber for vacuum ultraviolet calibration and testing of extreme and far ultraviolet (UV) sensors. The system is used to determine an instrument's optical characteristics by simulating the naturally occurring diffuse airglow emissions of the Earth's upper atmosphere. It is also capable of performing component-level testing and characterization of an instrument's individual optical components before instrument assembly

INSTRUMENTATION: The facility consists of three vacuum vessels specifically designed for the fabrication and testing of sensors and components operating in the 80 to 170-nm spectrum. The primary vacuum vessel is a 1.67-m diameter by 2-m long stainless steel tank. This chamber is evacuated using oil-free cryogenic, turbo and roughing pumps with a typical operating pressure of 1×10^{-6} Torr. Unltraviolet radiation is delivered into this system using two gas discharge lamps. The lamps can be configured for directed beam applications or as a diffuse source or both simultaneously. Inside the chamber are several motion stages for remote positioning of the instrument or component being tested. Another vacuum vessel in the facility includes a chamber for independently testing and assembling far ultraviolet sealed tube detectors. The facility includes a vacuum chamber dedicated to the deposition of thin film photocathodes and a 0.6-m diameter chamber for thermal vacuum testing components or small instruments that require stimulation of ultraviolet radiation.

DESCRIPTION: The Vacuum Ultraviolet Calibration Facility is a series of clean vacuum chambers capable of generating and detecting UV radiation required for optical calibration of space experiments. It was built to support the optical development, testing, and calibration of the Special Sensor Ultraviolet Limb Imager (SSULI). Using an advanced graphical interface, the facility can be easily reconfigured for a wide variety of UV measurements. A silicon carbide reflection diffuser provides diffuse radiation in the far and extreme UV portion of the spectrum. Calibrated reference detectors monitor the radiation levels during an experiment. Inside the chamber, precision translation and rotation stages allow motion of the test component along four independent axes. To minimize contamination, the end of the vacuum chamber is inside a Class 1000 clean room. The entire facility can be be used interactively, and work is in progress to automate the facility, allowing remote monitoring via a network connection.

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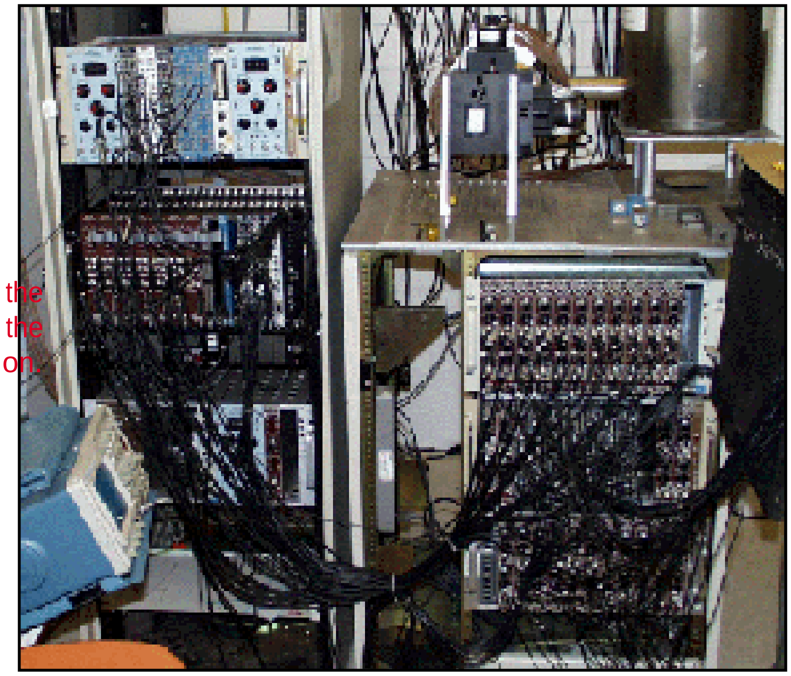
Solid-State Position-Sensitive Detector Evaluation Facility

The SHIMMER instrument, shown here in the laboratory, is being prepared for flight on the Space Shuttle and International Space Station.



CAMAC data acquisition system

FUNCTION: Develops position-sensitive radiation detectors for a diverse range of hard X-ray and gamma detection applications. New-technology detectors will push the capabilities of instrumentation in gamma-ray astrophysics, environmental remediation, nuclear nonproliferation, and medicine. The laboratory provides the electronics and handling capabilities to quickly and accurately test and evaluate a wide variety of new detector technologies.

INSTRUMENTATION: Our inventory includes many hundred low-noise preamplifiers, shaping amplifiers, discriminators, analog-to-digital converters, and time-to-digital converters. These are easily configured to support a variety of experimental needs. In addition, custom CMOS systems have been developed for particular applications, many of which can be used with a variety of detectors. Computer-controlled position tables provide the ability to scan detectors with collimated radioactive beams. Vacuum apparatus and thermal chambers permit testing detectors that operate at temperatures ranging from 77K through 373K. In addition, several imaging detectors are available, including 10 germanium strip detectors.

DESCRIPTION: The laboratory consists of several easily configurable data acquisition systems that can process spectroscopy signals from approximately 200 simultaneous channels. Several CAMAC and VME crates support much of this, in addition to a variety of specialized readout systems based on custom CMOS chips. Energy resolution of 1.4 keV FWHM in germanium has been achieved using room-temperature electronics. A variety of imaging germanium, silicon, and scintillation detectors are available that can be configured in coincidence or as stand-alone devices. The combination of these detectors permits the study of complicated systems such as a Compton telescope and coded-aperture imagers.

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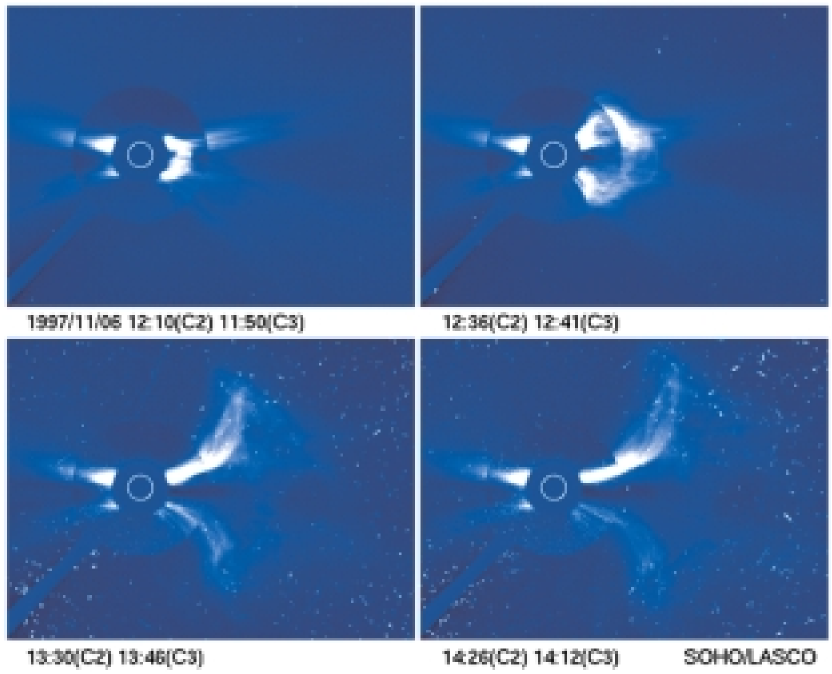
The Large Angle and Spectrometric Coronagraph (LASCO)



Images of a coronal mass ejection that occurred on 6 November 2000

FUNCTION: Designed to answer some fundamental questions: How is the corona heated? Where and how is the solar wind accelerated? What causes coronal mass ejections, and what role do they play in the evolutionary development of large-scale coronal patterns?

INSTRUMENTATION: The LASCO instrument is a suite of three coronagraphs that image the solar corona from 1.1 to 32 solar radii. It is convenient to measure distances in terms of solar radii. One solar radius is about 700,000 km, 420,000 miles, or 16 arc min. The EIT instrument images the solar disk to 1.5 solar radii in four narrow wavelength intervals from 17.1 to 30.4 nm. These intervals roughly correspond to ionization temperatures of 60,000 K to 3 MK.

DESCRIPTION: The LASCO and EIT instruments are two of 11 instruments included on the joint NASA/ESA SOHO (Solar and Heliospheric Observatory) spacecraft. SOHO was launched on 2 December 1995 at 0808 UT (0308 EST) from the Kennedy Space Center, Cape Canaveral, Florida. The spacecraft is located about 1 million miles from Earth, between Earth and the Sun in a halo orbit about the L1 Lagrangian point. This point is where the gravitational and orbital forces are balanced. About 250 images are returned from LASCO and EIT each day, providing unprecedented views of the Sun and its corona.

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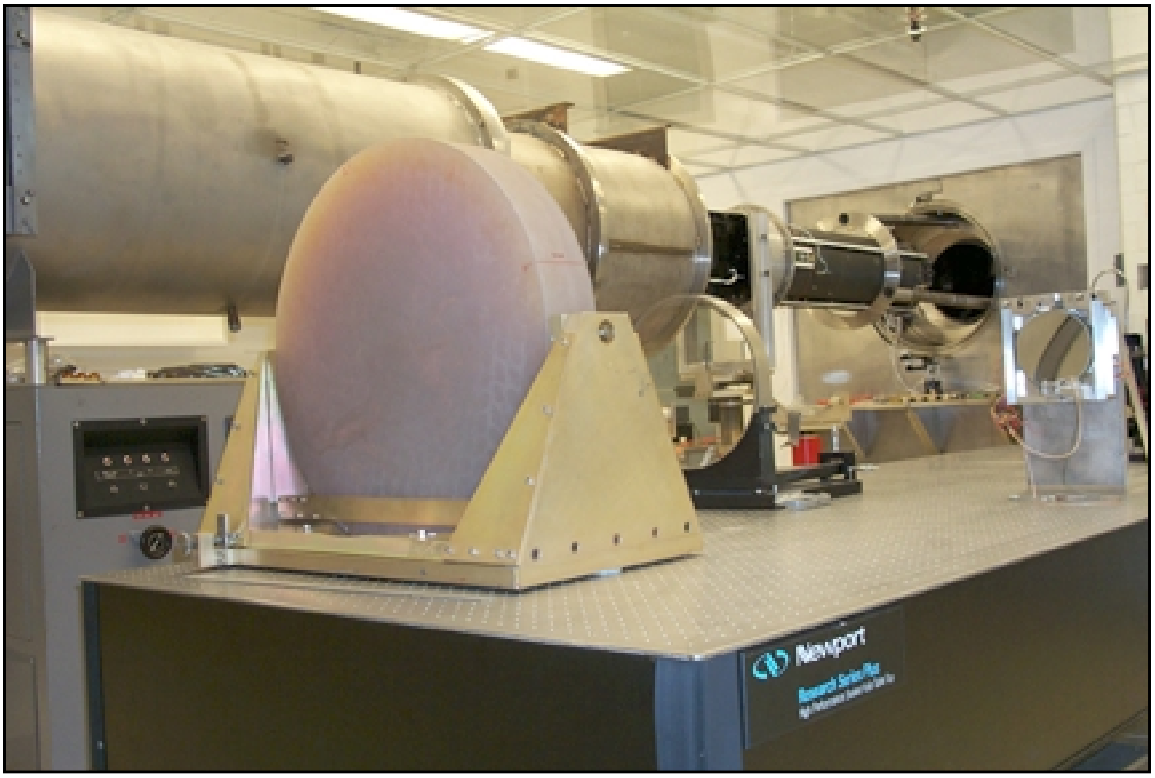
Rocket Assembly and Checkout Facility



Rocket Assembly / Checkout Facility

FUNCTION: Integrates, tests, and calibrates scientific instruments flown on sounding rocket payloads. The scientific instruments are assembled on an optical bench; the electronic components are installed and tested; and the instrument is moved to the vacuum calibration chamber for spectroradiometric calibration. When removed from the chamber, the payload is ready for shipment to White Sands Missile Range (WSMR), NM, for integration with the spacecraft and launch vehicle.

INSTRUMENTATION: Air hood, ultrasonic cleaner, particle counter, vacuum bake chamber with thermally controlled quartz crystal microbalance, oscilloscope, flight instrument computers

DESCRIPTION: The facility consists of six contiguous laboratory modules subdivided into a storage area, a gray room area, and a clean room. The storage area houses spare instrument components and intermittently used ground support equipment. The gray room area contains facilities to clean components before they enter the clean room and equipment used to ship the instrument to WSMR. The Class 100 cross-flow clean room is separated from the gray room by an air shower. The clean room contains three major stations: a clean bench for assembly of subsystems; a 12 × 4-ft optical bench for instrument assembly and electronic test of the instrument subsystems; and a vacuum chamber for vacuum focus and spectroradiometric calibration. The cryogenically pumped vacuum chamber is designed with a 30-cm diameter ultraviolet collimator at one end and a roll-off section that accommodates the entire flight instrument centered in the collimated beam at the other end.

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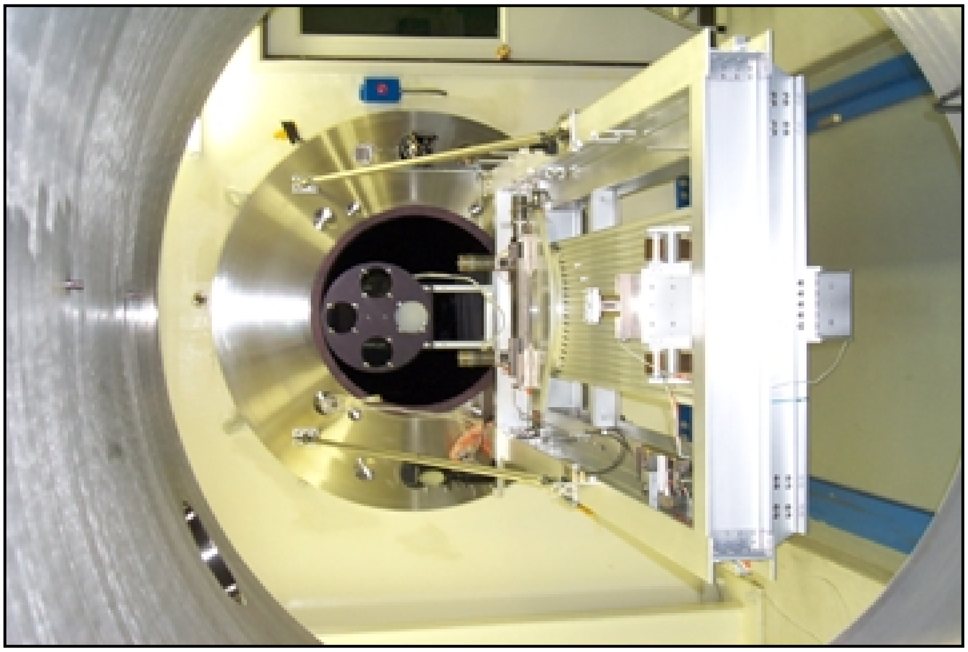
Solar Coronagraph Optical Test Chamber (SCOTCH)



Solar Coronagraph Optical Test Chamber

FUNCTION: Provides a facility for the assembly, test, and vacuum optical characterization of solar and coronal satellite instrumentation under ultraclean conditions.

INSTRUMENTATION: The SCOTCH is instrumented with temperature-controlled quartz crystal monitors and residual gas analyzers for real-time, quantitative measurements of volatile contamination. Various light sources can be introduced at one end of the 11-m chamber. This includes a solar spectrum simulator, the solar disk itself, as well as other visible and XUV sources. The chamber contains an instrument-pointing table capable of supporting payloads with a mass of 175 kg. The precision of the pointing table is <1 arc-second.

DESCRIPTION: The large Solar Coronagraph Optical Test Chamber (SCOTCH) is the primary test chamber located within a 400-ft^2 Class 10 clean room. This completely dry-pumped, 550 ft^3 vacuum chamber is maintained at synchrotron levels of cleanliness. Solar instrumentation up to 1 m in diameter and 5 m in length can be physically accommodated in the chamber. An instrument's optical performance is probed and calibrated with a variety of visible and XUV sources mounted on the chamber's 11-m beamline. The instrument is mounted on a precision pointing table equipped with motorized slides, which allows controlled adjustment of instrument pointing with sub-arcsecond precision under evacuated conditions. The main beamline is baffled to eliminate stray reflections from the beamline walls and minimize the effect of light scattered off the instrument surfaces. A solar disk stray light rejection of 10^{-12} was successfully measured in the Large Angle Spectroscopic Coronagraph (LASCO) C3 channel.

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Space Instrument Test Facility (SITF)

Space Instrument Test Facility

FUNCTION: Enables flight optics and sensors to be assembled and tested under conditions designed to minimize particulate and volatile contamination of the flight hardware. The SITF was used for the test and assembly of the Large Angle Spectrometric Coronagraph (LASCO) and is currently being used to develop and test the next generation of solar-space-based instrumentation.

INSTRUMENTATION: SCOTCH is instrumented with a temperature-controlled quartz crystal microbalance and a residual gas analyzer to monitor chamber and instrument outgassing. Electrical and liquid nitrogen vacuum feed-throughs are available through ports in the tank. A large retractable bell jar pulls back into the Class 10 instrument clean room to provide access to the instrument pointing platform. To facilitate instrument handling, assembly, and alignment operations, the clean room contains a 1.3 × 7-m vibration-isolated optical bench and an overhead crane adapted for clean room use with a 1 ton load capacity. A variety of calibrated optical sources, collimators, and theodolites are available to support in-air optical test, alignment and assembly operations.

DESCRIPTION: The SITF provides a clean, controlled environment for the optical calibration and assembly of modern space-based solar instrumentation. The unique requirements of this instrumentation require a rigorous approach to contamination control. The instrument vacuum test chamber, the Solar Coronagraph Optical Test Chamber (SCOTCH), forms the primary optical test chamber and is described more fully on the previous page. The instrument handling and assembly is conducted in a Class 10 clean room to reduce particulate generation. Airborne particulate levels are continuously monitored. To prevent hydrocarbon contamination, the clean room air is filtered through activated carbon filters located in the central plenum ducts. The facility also contains a small, well-instrumented thermal vacuum / bake test chamber. This allows characterization of outgassing of components and subassemblies prior to integration in the main instrument structure.

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